Description of the Invention

Applicant's invention relates to a method for preparing membrane electrode assemblies (MEAs), and in particular to a method of manufacturing a proton-conducting cation-exchange electrolyte membrane for use in a membrane electrode assembly (MEA), in which atmospheric pressure plasma deposition is used to deposit catalysts such as platinum onto a polymer substrate, or a substrate including carbon cloth or carbon particles. The invention has two principal characteristics:

1) The noble metal catalyst is deposited on the membrane by discharge enhanced chemical vapor deposition (DECVD); and

2) The DECVD is carried out at atmospheric pressure, without adding noble gases to the DECVD carrier gas.

REMARKS

Claims 1, 3-9, and 11-16 are pending, and stand finally rejected.

35 U.S.C. §103

Dearmley in view of Allen and further in view of Kirk-Othmer and Fornsel

Claims 1, 4-5 and 11-13 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Dearmaley (US Patent Number 6,159,533) in view of Allen (US Patent Number 6,077621and further in view of Kirk-Othmer and Fornsel (WO 01/32949, US 6,800,336). The references fail to teach or suggest all of Applicant's claim limitations, as amended, thus no *prima facie* case of obviousness is presented. Specifically, the references fail to teach or suggest a method for manufacturing a cation-exchange membrane by DECVD, where the deposition is carried out at atmospheric pressure without adding a noble gas to the DECVD carrier gas, as set forth in Applicant's previous response.

Dearnley

The Dearnley reference discloses a vapor deposition method for depositing a catalyst on a fuel cell electrode under vacuum. The Dearnley reference fails to disclose Applicant's method using a carrier gas, and at atmospheric pressure. The Dearnley reference is silent on not adding a noble gas to the carrier gas – since no carrier gas is involved. The Dearnley reference not only fails to teach or suggest two critical limitations in Applicant's claims (carrier gas and an atmospheric pressure process), it teaches away for Applicant's claims by requiring a vacuum deposition and void of a carrier gas. One in the art would not be motivated to practice Applicant's atmospheric, carrier gas method from the vacuum process without a carrier gas disclosed in the Dearnley reference.

Allen

The Allen reference describes a process for preparing an io-conducting membrane by subjecting under vacuum the membrane to a low energy electron beam. For cleaning the membrane, then subjecting under vacuum the membrane to a high energy electron beam containing metal ions. As with the Dearnley reference above, the process of Allen is a vacuum process. One in the art would not be motivated to practice Applicant's atmospheric, carrier gas method from the vacuum process without a carrier gas as disclosed in the Allen reference.

Applicant believes the Examiner cites the Allen reference, not for the specific process taught by Allen which is not done at atmospheric temperature, but rather for the description in the Allen reference of the State of the Art. The Allen background describes methods of depositing heavy metal ions that include ultra-high vacuum (UHV), evaporation, chemical vapor deposition (CVD) and sputter deposition. The Examiner concludes that these methods are substitutes for each other, and thus CVD could be used to achieve a similar result to that of the Dearnley reference. However, while column 2, lines 58-65 describe a CVD process at atmospheric temperature, it also points out that the constituents of a vapor phase are often diluted with an inert gas. Applicant claims a discharged enhanced chemical vapor deposition which is a different process than a CVD process such as that described by Allen. Further, while the Allen reference points out

that a CVD process uses an additional inert carrier gas, Applicant's claimed process is "without adding noble gasses to the DECVD carrier gas. One of skill in the art would not be motivated to practice the DECVD process of Applicant's claims from a reference to a CVD process, and most certainly would not be motivated to practice Applicant's claims of no added noble gas from a description of the use of an inert carrier gas. The Allen teaching of an inert carrier gas is exactly opposite and teaches away from Applicant's claims of no added noble gas.

Kirk-Othmer

The Kirk-Othmer reference is a secondary reference used to show plasma enhanced chemical vapor deposition. The Kirk-Othmer reference deals primarily with methods for depositing coatings such as Si, Al, Ti, B, W, and not with the deposition of a catalyst, as claimed by Applicant. Moreover, the Kirk-Othmer reference points out that plasma CVD is best at low gas pressure (page 5, first full paragraph). There is nothing in the Kirk-Othmer reference to motivate one to combine atmospheric pressure plasma deposition of a catalyst by DECVD without adding noble gases to the carrier gas. And the Kirk-Othmer reference also fails to heal the deficiencies of Dearnley and Allen teaching a low pressure or vacuum process rather than one at atmospheric temperature. Indeed the teaching of Kirk-Othmer of a preferred low pressure process teaches away from Applicant's claim of an atmospheric pressure process.

Fornsel

The Fornsel reference describes the use of an atmospheric plasma method for reacting monomers to form a polymer coating on a striated substrate. The Fornsel reference fails to teach or suggest Applicant's claim limitations of a method for producing a cation-exchange electrolyte membrane, the deposition of a catalyst layer or a substrate of a polymer membrane, carbon cloth of carbon particle-containing membrane. Rather it teaches away from the coating of a catalyst layer on a membrane by describing only the reaction of monomers to form a polymer coating on a striated substrate. One would not be motivated to combine a method for applying a polymer coating (Fornsel),

with a reference requiring a noble gas in metallurgy applications, or with a vacuum method for depositing a catalyst on a membrane.

Dearnley in view of Allen and further in view of Kirk-Othmer and Fornsel and further in view of Schutze

Claim 3, stands rejected under 35 U.S.C. 103(a) as being unpatentable over Dearnaley (US Patent Number 6,159,533) in view of Allen (US Patent Number 6,077621and further in view of Kirk-Othmer and Fornsel (WO 01/32949, US 6,800,336) and further in view of Schutze. The Schutze The Schutze reference teaches a plasma jet using flowing helium. Applicant's amended claims cite a method without adding noble gases to the DECVD carrier gas. The Schutze reference not only fails to teach or suggest Applicant's claim limitation of no added noble gas, but teaches away from Applicant's claims by requiring a noble gas. The Schutze reference fails to correct the deficiencies of the Dearnley reference, fails to teach or suggest Applicant's claim limitations, and teaches away from Applicant's claims.

Further in view of Hulett

Claim 6 is rejected over the references cited above, further in view of Hulett. The Hulett reference is a secondary reference used to describe advancing the membrane beneath the nozzle. The Hulett reference describes an unrelated slurry-coated membrane method, which is very different from a vapor deposition method of forming a coating. In the Dearnaley reference describing a vacuum system, the enclosed area is so small as to prevent moving the membrane – and there is no nozzle. Thus the proposed modification would render the prior art unsatisfactory for its intended use, which is not allowed in a *prima facie* case of obviousness according to MPEP 2143.

Even if somehow these mutually exclusive methods were combined, the Hulett reference fails to heal the defects of the cited references, as described above.

Further in view of Yasumoto

Claim 7 stands rejected further in view of Yasumoto (US 2003/0096154). The Yasumoto is a secondary reference cited by the Examiner to teach the spraying of the catalyst onto the surface of the polymer electrode membrane. Applicant's do not claim a method in which a catalyst is sprayed onto a polymer electrode membrane, but rather a discharge enhanced chemical vapor deposition method. Thus the Yasumoto reference fails to teach Applicant's claims.

Further in view of Nanaumi

Claims 8-9 stand rejected under 35 U.S.C. 103(a) as being unpatebtable further in view of Nanaumi (US 2004/0180250).

The Nanaumi reference is cited to cite polymer electrolyte membrane structures. However the Nanaumi reference fails to teach or suggest Applicant's many claim limitations, and fails to correct the many deficiencies of the other references cited.

Further in view of Kamo

Claims 14 and 15 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Dearnaley (US Patent Number 6,159,533) in view of Schutze in view of Fornsel (WO 01/32949, US 6.800.336), and further in view of Kamo (US 2003/0059659). The Kamo reference is a secondary reference cited to show the use of a platinum alloy in the anode side of an electrolyte membrane. While the Kamo reference discloses a platinum/ruthenium alloy for a fuel cell electrode, the platinum/ruthenium alloy is supported on a carbon powder, rather than directly on a membrane as claimed by Applicant. In Example 2, the platinum/ruthenium alloy is screen printed using a slurry. One in the art would not be motivated by this method alone – or in combination with the other cited reference to practice all of the limitations in Applicant's amended claims.

Further in view of Haug

Claim 16 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Dearnaley (US Patent Number 6,159,533) in view of Schutze in view of Fornsel (WO 01/32949, US 6.800.336), and further in view of Haug. The Haug reference is a secondary reference cited to show the deposition of multiple catalyst layers. The Haug

reference demonstrates the use of a vacuum sputter deposition system for producing a PEM. The disclosure of a multiple layer of catalyst by methods teaching away from Applicant's claimed method fails to heal the defects of the cited art to present a *prima facie* case of obviousness.

Conclusion

The references cited, either alone or in combination, fail to teach or suggest all of Applicant's claim limitations, and therefore fail to present a *prima facie* case of obviousness over Applicant's amended claims. For the above reasons the present claims 1, 3-9, and 11-16 are believed by the Applicant to be novel and unobvious over the prior art, thus the claims herein should be allowable to the Applicant. Accordingly, reconsideration and allowance are requested.

Accordingly, reconsideration and allowance are requested.

Respectfully submitted.

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